

1 CLAIMS:

2 Having thus described my invention, what I claim as new and
3 desire to secure by Letters Patent is as follows:

4 1. A signal separation method comprising restoring an
5 original signal from observed data, obtained by observing
6 multiple mixed signals, including the steps of:

7 estimating, from said observed data, a separation
8 matrix using an adaptive filter that suppresses the H-
9 infinity norm concerning said separation matrix until the
10 H-infinity norm is equal to or smaller than a provided
11 scalar value; and

12 restoring said original signal by multiplying said
13 separation matrix by said observed data.

14 2. A signal separation method comprising the steps of:

15 selecting, for said observed data, a specific
16 separation matrix from among multiple separation matrixes
17 based on MinMax strategy in game theory; and

18 restoring an original signal by multiplying said
19 selected separation matrix by said observed data.

20 3. A signal separation method comprising:

21 estimating and restoring an original signal from observed
22 data obtained by observing multiple mixed signals, which
23 include said original signal, including the steps of:

24 introducing, for said observed data, a cost function
25 based on a function having a monotonously increasing

1 characteristic;
2 estimating a separation matrix using an adaptive filter
3 that optimizes said cost function; and
4 estimating and restoring said original signal by
5 multiplying said separation matrix by said observed data.

6 4. The signal separation method according to claim 3,
7 wherein, the step of estimating a separation matrix includes
8 employing an adaptive filter for minimizing said cost
9 function for said separation matrix.

10 5. The signal separation method according to claim 3,
11 wherein said cost function to be introduced is an
12 exponential type function.

13 6. A signal separation method comprising:
14 separating and extracting an original signal from observed
15 data obtained by observing multiple mixed signals, which
16 include said original signal, including the steps of:
17 reading observed signals;
18 subtracting the average of said observed signals and
19 performing zero averaging for said observed signals;
20 whitening the observed signals obtained by zero
21 averaging;
22 separating said whitened observed signals based on a
23 cost function that has a monotonously increasing
24 characteristic; and
25 performing, as a post processing, inverse whitening for
26 the obtained observed signals.

7. The signal separation method according to claim 6,
further comprising changing a non-linear function to be used
in said cost function employed for said separation based on
the kurtosis of each of said observed signals.

8. A signal processing apparatus comprising:
input means, for receiving observed data obtained by
observing multiple mixed signals, which include an original
signal;
separation matrix estimation means, for estimating, for
said observed data, a separation matrix using adaptive
filtering for suppressing the H-infinity norm concerning
said separation matrix until the H-infinity norm is to equal
to or smaller than a provided scalar value; and
estimation/restoration means, for estimating and
restoring said original signal by multiplying said
separation matrix by said observed data.

9. A signal processing apparatus comprising:
input means, for receiving observed data obtained by
observing multiple mixed signals, which include an original
signal;
selection means, for employing, for said observed data,
the MinMax strategy in game theory to select, from
separation matrixes, a specific separation matrix; and
estimation/restoration means, for estimating and
restoring an original signal by multiplying said separation
matrix by said observed data.

10. A signal processing apparatus comprising:

1 input means, for receiving observed data obtained by
2 observing multiple mixed signals;
3 separation matrix estimation means, for estimating, for
4 said observed data received from said input means, a
5 separation matrix by using an adaptive filter with
6 optimizing a cost function that is based on a function
7 having a monotonously increasing characteristic; and
8 estimation/restoration means, for estimating and
9 restoring an original signal by multiplying said separation
10 matrix by said observed data.

11 11. The signal processing apparatus according to claim 10,
12 wherein said adaptive filter used for said separation matrix
13 estimation means includes a filter for minimizing said cost
14 function for said separation matrix, and said function
15 having said monotonously increasing characteristic is an
16 exponential type function.

17 12. A signal processing apparatus comprising:
18 a non-linear function unit, for performing a non-linear
19 function for an input observed signal and a separation
20 matrix estimated during a previous cycle;

21 an error signal calculator, for calculating an error
22 signal based on the value obtained by said non-linear
23 function unit, said separation matrix estimated during the
24 previous cycle, and said observed signal at a present time;
25 and

26 a separation matrix update unit, for updating said
27 separation matrix estimated at said time based on said error
28 signal, so that error evaluation is weighted by said cost

1 function having the monotonously increasing characteristic,
2 for outputting and/or separating an original signal from an
3 input observed signal.

4 13. The signal processing apparatus according to claim 12,
5 further comprising:

6 a unitarization operator for ensuring the transform to
7 a unitary matrix of said separation matrix that has been
8 estimated at said time and that has been updated by said
9 separation matrix update unit.

10 14. A signal processing apparatus comprising:

11 input means, for receiving mixed speech data obtained
12 by observing multiple mixed speech signals;

13 separation matrix estimation means, for estimating a
14 separation matrix, for said mixed speech data, using an
15 adaptive filter with optimizing a cost function that is
16 based on a function having a monotonously increasing
17 characteristic; and

18 separation/extraction means, for separating and
19 extracting said speech signals from said mixed speech data
20 by multiplying said separation matrix by said mixed speech
21 data.

22 15. A signal processing apparatus for separating an
23 artifact from an observed bio-signal, said apparatus
24 comprising:

25 input means, for receiving observed data containing
26 said artifact in said observed bio-signal;

27 separation matrix estimation means, for estimating a

1 separation matrix for said observed data, using an adaptive
2 filter with optimizing a cost function that is based on a
3 function having a monotonously increasing characteristic;
4 and
5 separation/extraction means for separating and
6 extracting said observed bio-signal from said observed data
7 by multiplying said separation matrix by said observed data.

8 16. The signal processing apparatus according to claim 15,
9 wherein said observed bio-signal is at least one signal of a
10 signal observed using magnetoencephalography or a signal
11 observed using electroencephalography.

12 17. A signal processing apparatus for extracting from
13 economic statistical data, a fluctuation element that is
14 hidden during an observation, comprising:
15 input means, for receiving economic statistical data;
16 separation matrix estimation means, for estimating a
17 separation matrix for said economic statistical data using
18 an adaptive filter with optimizing a cost function that is
19 based on a function having a monotonously increasing
20 characteristic; and
21 separation/extraction means, for separating and
22 extracting said fluctuation element from said economic
23 statistical data by multiplying said separation matrix by
24 said economic statistical data.

25 18. The signal processing apparatus according to claim 17,
26 wherein said economic statistical data, received by said
27 input means, is management data that can be considered as

1 the data that consists of the overall trend and individual
2 factors synthesized by an unknown mixing matrix.

3 19. The signal processing apparatus according to claim 17,
4 wherein said economic statistical data are stock price
5 fluctuation data that are observed as a set, and said
6 fluctuation element that is separated and extracted by said
7 separation/extraction means is a stock price trend for an
8 independent component that can be applied for portfolio
9 return prediction.

10 20. A mobile terminal device, for receiving, from a base
11 station for code division multiple access, observed data
12 that include the spread information to other users, and for
13 extracting a local user signal from said observed data,
14 comprising:

15 input means, for receiving observed data from said base
16 station;

17 separation matrix estimation means, for estimating a
18 separation matrix for said observed data using an adaptive
19 filter with optimizing a cost function that is further based
20 on a function having a monotonously increasing
21 characteristic; and

22 separation/extraction means, for separating and
23 extracting a user signal from said observed data by
24 multiplying said separation matrix by said observed data.

25 21. An article of manufacture comprising a computer usable
26 medium having computer readable program code means embodied
27 therein for causing signal separation, the computer readable

1 program code means in said article of manufacture comprising
2 computer readable program code means for causing a computer
3 to effect the steps of claim 1.

4 22. An article of manufacture comprising a computer usable
5 medium having computer readable program code means embodied
6 therein for causing signal separation, the computer readable
7 program code means in said article of manufacture comprising
8 computer readable program code means for causing a computer
9 to effect the steps of claim 2.

10 23. An article of manufacture comprising a computer usable
11 medium having computer readable program code means embodied
12 therein for causing signal separation, the computer readable
13 program code means in said article of manufacture comprising
14 computer readable program code means for causing a computer
15 to effect the steps of claim 3.

16 24. An article of manufacture comprising a computer usable
17 medium having computer readable program code means embodied
18 therein for causing signal separation, the computer readable
19 program code means in said article of manufacture comprising
20 computer readable program code means for causing a computer
21 to effect the steps of claim 6.

22 25. A computer program product comprising a computer usable
23 medium having computer readable program code means embodied
24 therein for causing signal processing, the computer readable
25 program code means in said computer program product
26 comprising computer readable program code means for causing

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1 a computer to effect the functions of claim 8.

2 25. A computer program product comprising a computer usable
3 medium having computer readable program code means embodied
4 therein for causing signal processing, the computer readable
5 program code means in said computer program product
6 comprising computer readable program code means for causing
7 a computer to effect the functions of claim 8.

8 26. A computer program product comprising a computer usable
9 medium having computer readable program code means embodied
10 therein for causing signal processing, the computer readable
11 program code means in said computer program product
12 comprising computer readable program code means for causing
13 a computer to effect the functions of claim 9.

14 27. A computer program product comprising a computer usable
15 medium having computer readable program code means embodied
16 therein for causing signal processing, the computer readable
17 program code means in said computer program product
18 comprising computer readable program code means for causing
19 a computer to effect the functions of claim 10.

20 28. A computer program product comprising a computer usable
21 medium having computer readable program code means embodied
22 therein for causing signal processing, the computer readable
23 program code means in said computer program product
24 comprising computer readable program code means for causing
25 a computer to effect the functions of claim 12.

1 29. A computer program product comprising a computer usable
2 medium having computer readable program code means embodied
3 therein for causing signal processing, the computer readable
4 program code means in said computer program product
5 comprising computer readable program code means for causing
6 a computer to effect the functions of claim 14.

7 30. A computer program product comprising a computer usable
8 medium having computer readable program code means embodied
9 therein for causing signal processing, the computer readable
10 program code means in said computer program product
11 comprising computer readable program code means for causing
12 a computer to effect the functions of claim 15.

13 31. A computer program product comprising a computer usable
14 medium having computer readable program code means embodied
15 therein for causing signal processing, the computer readable
16 program code means in said computer program product
17 comprising computer readable program code means for causing
18 a computer to effect the functions of claim 17.

19 32. A computer program product comprising a computer usable
20 medium having computer readable program code means embodied
21 therein for causing functions of the mobile terminal device,
22 the computer readable program code means in said computer
23 program product comprising computer readable program code
24 means for causing a computer to effect the functions of
25 claim 20.

26 33. A program storage device readable by machine, tangibly

1 embodying a program of instructions executable by the
2 machine to perform method steps for signal processing, said
3 method steps comprising the steps of claim 1.

4 33. A program storage device readable by machine, tangibly
5 embodying a program of instructions executable by the
6 machine to perform method steps for signal processing, said
7 method steps comprising the steps of claim 3.

8 34. A program storage device readable by machine, tangibly
9 embodying a program of instructions executable by the
10 machine to perform method steps for signal processing, said
11 method steps comprising the steps of claim 6.